What is claimed is:

1   1. A method for synthesizing an auditory scene, comprising:

2   processing at least one input channel to generate two or more processed input signals;

3   filtering the at least one input channel to generate two or more diffuse signals; and

4   combining the two or more diffuse signals with the two or more processed input signals to generate a

5   plurality of output channels for the auditory scene.

1   2. The invention of claim 1, wherein processing the at least one input channel comprises:

2   converting the at least one input channel from a time domain into a frequency domain to generate a

3   plurality of frequency-domain (FD) input signals;

4   delaying the FD input signals to generate a plurality of delayed FD signals; and

5   scaling the delayed FD signals to generate a plurality of scaled, delayed FD signals.

1   3. The invention of claim 2, wherein:

2   the FD input signals are delayed based on inter-channel time difference (ICTD) data; and

3   the delayed FD signals are scaled based on inter-channel level difference (ICLD) and inter-channel

4   correlation (ICC) data.

1   4. The invention of claim 3, wherein:

2   the at least one input channel is at least one combined channel generated by performing binaural cue

3   coding (BCC) on an original auditory scene; and

4   the ICTD, ICLD, and ICC data are cue codes derived during the BCC coding of the original auditory

5   scene.

1   5. The invention of claim 4, wherein the at least one combined channel and the cue codes are

2   transmitted from an audio encoder that performs the BCC coding of the original auditory scene.

1   6. The invention of claim 3, wherein different ICTD, ICLD, and ICC data are applied to different

2   frequency sub-bands of the corresponding FD signals.

1   7. The invention of claim 2, wherein:

2   the diffuse signals are FD signals; and

3   the combining comprises, for each output channel:

4   summing one of the scaled, delayed FD signals and a corresponding one of the FD diffuse input

5   signals to generate an FD output signal; and

6   converting the FD output signal from the frequency domain into the time domain to generate the

7   output channel.

1   8.   The invention of claim 7, wherein filtering the at least one input channel comprises:

2   applying two or more late reverberation filters to the at least one input channel to generate a plurality

3   of diffuse channels;

4   converting the diffuse channels from the time domain into the frequency domain to generate a

5   plurality of FD diffuse signals; and

6   scaling the FD diffuse signals to generate a plurality of scaled FD diffuse signals, wherein the scaled

7   FD diffuse signals are combined with the scaled, delayed FD input signals to generate the FD output

8   signals.

1   9.   The invention of claim 8, wherein:

2   the FD diffuse signals are scaled based on ICLD and ICC data;

3   the at least one input channel is at least one combined channel generated by performing BCC coding

4   on an original auditory scene; and

5   the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

1   10. The invention of claim 9, wherein the at least one combined channel and the cue codes are

2   transmitted from an audio encoder that performs the BCC coding of the original auditory scene.

1   11. The invention of claim 9, wherein different ICLD and ICC data are applied to different frequency

2   sub-bands of the corresponding FD signals.

1   12. The invention of claim 7, wherein filtering the at least one input channel comprises:

2   applying two or more FD late reverberation filters to the FD input signals to generate a plurality of

3   diffuse FD signals; and

4   scaling the diffuse FD signals to generate a plurality of scaled diffuse FD signals, wherein the scaled

5   diffuse FD signals are combined with the scaled, delayed FD input signals to generate the FD output

6   signals.

1   13. The invention of claim 12, wherein:

2   the diffuse FD signals are scaled based on ICLD and ICC data;

3   the at least one input channel is at least one combined channel generated by performing BCC coding

4   on an original auditory scene; and

5   the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

1   14. The invention of claim 13, wherein different ICLD and ICC data are applied to different

2   frequency sub-bands of the corresponding FD signals.

1   15. The invention of claim 1, wherein the method generates more than two output channels from the

2   at least one input channel

1   16. The invention of claim 15, wherein the method synthesizes a surround sound auditory scene.

1   17. The invention of claim 15, wherein a single input channel is used to synthesize the auditory

2   scene.

1   18. The invention of claim 1, wherein:

2   the method applies the processing, filtering, and combining for input channel frequencies less than a

3   specified threshold frequency; and

4   the method further applies alternative auditory scene synthesis processing for input channel

5   frequencies greater than the specified threshold frequency.

1   19. The invention of claim 18, wherein the alternative auditory scene synthesis processing involves

2   coherence-based BCC coding without the filtering that is applied to the input channel frequencies less

3   than the specified threshold frequency.

1   20. Apparatus for synthesizing an auditory scene, comprising:

2   means for processing at least one input channel to generate two or more processed input signals;

3   means for filtering the at least one input channel to generate two or more diffuse signals; and

4   means for combining the two or more diffuse signals with the two or more processed input signals to

5   generate a plurality of output channels for the auditory scene.

1   21. Apparatus for synthesizing an auditory scene, comprising:

2   a configuration of at least one time domain to frequency domain (TD-FD) converter and a plurality of

3   filters, the configuration adapted to generate two or more processed FD input signals and two or more

4   diffuse FD signals from at least one TD input channel;

5   two or more combiners adapted to combine the two or more diffuse FD signals with the two or more

6   processed FD input signals to generate a plurality of synthesized FD signals; and

7   two or more frequency domain to time domain (FD-TD) converters adapted to convert the

8   synthesized FD signals into a plurality of TD output channels for the auditory scene.

1   22. The invention of claim 21, wherein the configuration comprises:

2   a first TD-FD converter adapted to convert the at least one TD input channel into a plurality of FD

3   input signals;

4   a plurality of delay nodes adapted to delay the FD input signals to generate a plurality of delayed FD

5   signals; and

6   a plurality of multipliers adapted to scale the delayed FD signals to generate a plurality of scaled,

7   delayed FD signals.

1   23. The invention of claim 22, wherein:

2   the delay nodes are adapted to delay the FD input signals based on inter-channel time difference

3   (ICTD) data; and

4   the multipliers are adapted to scale the delayed FD signals based on inter-channel level difference

5   (ICLD) and inter-channel correlation (ICC) data.

1   24. The invention of claim 23, wherein:

2   the at least one input channel is at least one combined channel generated by performing binaural cue

3   coding (BCC) on an original auditory scene; and

4   the ICTD, ICLD, and ICC data are cue codes derived during the BCC coding of the original auditory

5   scene.

1   25. The invention of claim 23, wherein the configuration is adapted to apply different ICTD, ICLD,

2   and ICC data to different frequency sub-bands of the corresponding FD signals.

1   26. The invention of claim 22, wherein the combiners are adapted to sum, for each output channel,

2   one of the scaled, delayed FD signals and a corresponding one of the diffuse FD signals to generate one

3   of the synthesized FD signals.

1   27. The invention of claim 26, wherein

2   each filter is a TD late reverberation filter adapted to generate a different TD diffuse channel from

3   the at least one TD input channel;

4   the configuration comprises, for each output channel in the auditory scene:

5   another TD-FD converter adapted to convert a corresponding TD diffuse channel into an FD

6   diffuse signal; and

7   an other multiplier adapted to scale the FD diffuse signal to generate a scaled FD diffuse signal,

8   wherein a corresponding combiner is adapted to combine the scaled FD diffuse signal with a

9   corresponding one of the scaled, delayed FD signals to generate one of the synthesized FD signals.

1   28. The invention of claim 27, wherein:

2   each other multiplier is adapted to scale the FD diffuse signal based on ICLD and ICC data;

3   the at least one input channel is at least one combined channel generated by performing BCC coding

4   on an original auditory scene; and

5   the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

1   29. The invention of claim 28, wherein the configuration applies different ICLD and ICC data to

2   different frequency sub-bands of the corresponding FD signals.

1   30. The invention of claim 26, wherein:

2   each filter is an FD late reverberation filter adapted to generate a different FD diffuse signal from one

3   of the FD input signals; and

4   the configuration further comprises a further plurality of multipliers adapted to scale the FD diffuse

5   signals to generate a plurality of scaled FD diffuse signals, wherein the combiners are adapted to

6   combine the scaled FD diffuse signals with the scaled, delayed FD signals to generate the synthesized FD

7   signals.

1   31. The invention of claim 30, wherein at least two FD late reverberation filters have different filter

2   lengths.

1   32. The invention of claim 30, wherein:

2   the FD diffuse signals are scaled based on ICLD and ICC data;

3   the at least one input channel is at least one combined channel generated by performing BCC coding

4   on an original auditory scene; and

5   the ICLD and ICC data are cue codes derived during the BCC coding of the original auditory scene.

1   33. The invention of claim 32, wherein the configuration applies different ICLD and ICC data to

2   different frequency sub-bands of the corresponding FD signals.

1   34. The invention of claim 21, wherein the apparatus is adapted to generate more than two output

2   channels from the at least one TD input channel.

1   35. The invention of claim 34, wherein the apparatus is adapted to synthesize a surround sound

2   auditory scene.

1   36. The invention of claim 34, wherein the apparatus is adapted to use a single input channel to

2   synthesize the auditory scene.

1   37. The invention of claim 21, wherein the apparatus comprises one filter for every output channel in

2   the auditory scene.

1   38. The invention of claim 21, wherein each filter has a substantially random frequency response

2   with a substantially flat spectral envelope.

1   39. The invention of claim 21, wherein:

2   the apparatus is adapted to generate, combine, and convert for TD input channel frequencies less than

3   a specified threshold frequency; and

4   the apparatus is further adapted to apply alternative auditory scene synthesis processing for TD input

5   channel frequencies greater than the specified threshold frequency.

1   40. The invention of claim 39, wherein the alternative auditory scene synthesis processing involves

2   coherence-based BCC coding without the filters that are applied to the TD input channel frequencies less

3   than the specified threshold frequency.